Bristol-Myers Squibb Manufacturing Company

Supplemental Vapor Intrusion Investigation Report Buildings 7, 8, 15, 18, 30, 42

Bristol-Myers Squibb Manufacturing Company
Humacao, Puerto Rico

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1.0 Introduction

Bristol-Myers Squibb Manufacturing Company (BMSMC) - Humacao Operations, has been implementing a RCRA Corrective Action Program in accordance with the provisions of Module III of its Final RCRA Hazardous Waste Management Permit No. PRD090021056 (RCRA permit). A site location map for the BMSMC facility in Humacao is provided in **Figure 1**.

This *Supplemental Vapor Intrusion Investigation Report Buildings 7, 8, 15, 18, 30, and 42* is the third of a series of reports prepared as part of a comprehensive vapor intrusion assessment conducted by BMSMC to evaluate health risks associated with vapor intrusion into occupied or potentially occupied buildings as discussed below.

The objective of the vapor intrusion investigation was to determine if the vapor intrusion pathway poses an unacceptable risk to potential receptors (i.e., complete exposure pathway). According to the USEPA (USEPA, 2015a), a vapor intrusion pathway is considered complete when the following five conditions are met under current conditions:

1) A subsurface source of vapor-forming chemicals is present (e.g., in the soil or in groundwater) underneath or near the building;

2) Vapors form and have a route along which to migrate (be transported) toward the building;

3) The building is susceptible to soil gas entry, which means openings exist for the vapors to enter the building and driving 'forces' (e.g., air pressure differences between the building and the subsurface environment) exist to draw the vapors from the subsurface through the openings into the building;

4) One or more vapor-forming chemicals comprising the subsurface vapor source is present in the indoor environment; and

5) The building is occupied by one or more individuals when the vapor-forming chemical is present indoors.

The USEPA also notes that if one (or more) of the five conditions listed above is currently absent and is reasonably expected to be absent in the future, then the vapor intrusion pathway is considered to be incomplete (USEPA, 2015a).

As part of the initial phase of vapor intrusion investigation completed by BMSMC in 2012 at the Building 5 Area (SWMU 20), indoor air samples were collected in Building 5 and near-slab soil gas samples were collected at Building 6. In addition, at the Former Tank Farm Area (SWMU 3), sub-slab soil gas samples were collected at Building 8 and Building 11. This investigation was completed in accordance with the USEPA-approved *Soil Vapor Investigation Work Plan* (AMAI, 2012b). Results of the vapor intrusion sampling were submitted to the USEPA in the *Vapor Intrusion Investigation Report* (AMAI, 2012c).

As part of the second phase of vapor intrusion investigation, BMSMC submitted a *Building 5 Vapor Intrusion Work Plan* to the USEPA in August 2014. The revised *Building 5 Vapor Intrusion Work Plan* (Work Plan) was approved by the USEPA in December 2014 (AMAI, 2014). BMSMC implemented the *Building 5 Vapor Intrusion Work Plan* in December 2014 and based on the results of the sub-slab soil gas samples collected in Building 5, BMSMC decided to evaluate the potential for vapor intrusion in a portion of Building 6 which is located directly adjacent to Building 5. Sub-slab soil gas and indoor air samples were collected in Building 6 during the period February – June 2015 in accordance with the protocols presented in the Work Plan. Results of the vapor intrusion sampling were submitted to the USEPA in the *Building 5 Area (SWMU 20) Vapor Intrusion Investigation Report* (AMAI, 2015).

The present report presents the results of the vapor intrusion sampling conducted at Buildings 7, 8, 15, 18, 30, and 42 between August 2015 and July 2016. With the exception of the data collected in June and July 2016, all vapor intrusion data presented in this report was previously submitted to the USEPA in Quarterly Progress Reports. In addition, certain of the results have been discussed with the USEPA during Corrective Action meetings with the Agency.

Section 2 provides a Building 7 vapor intrusion evaluation including an area site description, a vapor intrusion sampling and analysis discussion, and a vapor intrusion investigation sampling results discussion. A similar approach is presented in Section 3 for Building 8, Section 4 for Building 15, Section 5 for Building 18, Section 6 for Building 30, and Section 7 for Building 42. Section 8 presents a summary, conclusions, and recommendations. References are included in Section 9.

2.0 Building 7 Vapor Intrusion Evaluation

2.1. Building 7 Area Site Description

Specific site characteristics important to the evaluation of the vapor intrusion pathway including a summary of previous subsurface investigations, building characteristics (including results from the indoor building surveys), and current and proposed building use are discussed below.

2.1.1. Groundwater Impacts

Building 7 is located southeast of the Former Tank Farm (**Figure 2**). Groundwater monitoring data collected in the vicinity of Building 7 in 2016 did not indicate any exceedances of the industrial groundwater concentrations for vapor intrusion screening levels.[1] A review of historic groundwater data collected at monitoring well MW-15, located approximately 110 feet upgradient of Building 7, did not indicate any exceedance of the industrial groundwater concentrations for vapor intrusion. BMSMC voluntarily conducted a vapor intrusion investigation at Building 7 as part of planned site reconfiguration activities, even though no recent or historic data triggered any requirements to conduct vapor intrusion sampling at this building.

2.1.2. Previous Vapor Intrusion Investigation Activities

No previous vapor intrusion investigation activities were conducted at Building 7.

2.1.3. Building Characteristics and Uses

Building 7 is a 29,780 square foot single-story building (**Figure 3**). The floor of Building 7 consists of reinforced concrete supported by concrete footings. The thickness of the floor slab is approximately 10 inches.

Building 7 currently contains the facility's administration departments, the facility's main employee cafeteria, a full-service kitchen, and a medical infirmary. The administrative departments are located mainly in the southern half of the building and consist of offices and large open rooms that contain office workstations/cubicles. The building also contains an electrical room, a computer server room, seven bathrooms, and several meeting and training rooms. This building is typically occupied during normal business hours, five days per week.

[1] The target industrial groundwater concentrations for vapor intrusion screening levels for this report were adjusted for an average groundwater temperature of 30°C, which is consistent with historical groundwater temperature data collected at the BMSMC facility.

The HVAC system for the building consists of five roof mounted packaged air conditioning systems, four dedicated roof top air conditioners, and one wall mounted split system air conditioner. The roof mounted packaged air conditioning units provide conditioned air to occupied portions of the building, except the offices and cubicles located in the southwest corner of the building which are served by a wall mount air conditioning unit and the data center located in the center of the building which is served by the four dedicated roof top air conditioners.

Building 7 was originally constructed in 1969 as the facility's administration building and its use since construction for office and meeting space has not changed.

2.2. Vapor Intrusion Sampling and Analysis

A vapor intrusion investigation was conducted at Building 7 to assess the vapor intrusion pathway and to evaluate the potential health risk associated with the inhalation of indoor air. All sampling and analysis protocols were completed in accordance with prior USEPA approved Work Plans.

May 2016

An indoor building survey was conducted in Building 7 on May 11, 2016. A completed Building 7 Survey Form is provided in **Appendix A**. Results of the building survey identified the following building conditions:

- The HVAC system was operating;
- Potential indoor sources of VOCs were identified and are listed on the Building 7 Survey Form;
- Floor drains were located in the cafeteria;
- No floor cracks were observed;
- Results of the PID screening for TVOC concentrations during the actual sampling (HVAC off) indicated the following:
    - TVOC concentrations in the breathing zone ranged from non-detect to 425 ppb in Building 7;
    - TVOC concentrations were highest in the southwest corner near sample location B7-3.

Six indoor air samples (B7IA-1 through B7IA-6) and an ambient air sample (B7AA) were collected for Building 7 at May 2016. A duplicate indoor air sample (B7IA-1D) was collected at

B7IA-1. Indoor and ambient air sample locations are shown on **Figure 3**.[2] The HVAC system was shut down for a period of 24 hours prior to the collection of the indoor air samples.

Indoor air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946) and a sorbent tube with a low flow air pump, programmed to pump 6 liters of air over a 24-hour period (TO-17). Canisters and sorbent tubes were positioned such that the sample inlet was approximately four feet above the ground floor (e.g. to assess air quality in the breathing zone). One ambient air sample (B7AA) was collected concurrently with the indoor air samples to establish outside background air quality conditions. Sample B7AA was located approximately 635 feet upwind (east) of Building 7 (see **Figure 3**).

Indoor and ambient air samples were submitted to Eurofins Air Toxics, Inc. (Eurofins) of Folsom, CA for analysis of VOCs according to USEPA Method TO-15, naphthalene by TO-17, and methane by ASTM D-1946. Method TO-17 is the USEPA recommended analytical method for low level analysis of naphthalene (Kerr et al., 2015) and is generally recommended by laboratories for reporting limit, reproducibility, and variability of data related issues. Completed Air Sampling Forms are provided in **Appendix B**.

June 2016

An indoor building survey was conducted in Building 7 on June 10, 2016 prior to completing the additional vapor intrusion sampling discussed below. A completed Building 7 Survey Form is provided in **Appendix A**. No changes in the building conditions were noted. TVOC concentrations in the breathing zone during sampling ranged from 21 ppb to 280 ppb. TVOC concentrations were highest in the southwest corner of the building near sample location B7-3.

Based on the results of the May 2016 sampling, an additional round of indoor air samples (B7IA-1 through B7IA-6), co-located sub-slab soil gas samples (B7SS-1 through B7SS-6), and an ambient air sample (B7AA) were collected in June 2016. A duplicate sub-slab soil gas sample (B7SS-1D) and a duplicate indoor air sample (B7IA-1D) were also collected.[3] Sample locations are shown on **Figure 3**. The HVAC system was shut down for a period of 24 hours prior to the collection of the sub-slab and indoor air samples.

[2] As part of the vapor intrusion investigation, samples were targeted to be collected in each building in all of the HVAC zones. In the case of Building 7, no samples were collected from the data center due to the presence of extensive computer operations in this area.

[3] All duplicate samples for Building 7 were collected at random sampling locations.

Indoor and ambient air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946) and a sorbent tube with a low flow air pump, programmed to pump 6 liters of air over a 24-hour period (TO-17). Canisters and sorbent tubes were positioned such that the sample inlet was approximately four feet above the ground floor. One ambient air sample (B7AA) was collected concurrently with the indoor air samples to establish outside background air quality conditions. Sample B7AA was located approximately 635 feet upwind (east) of Building 7 (see **Figure 3**).[4]

Prior to sampling the sub-slab soil gas, a 3/8-inch hole was drilled through the floor slab to approximately three inches below the floor slab. Teflon™-lined tubing was then inserted into the drill hole below the base of the floor slab. The annular space around the tubing was sealed using modeling clay and a helium leak check was completed to verify that the sub-slab soil gas sample point was properly sealed from indoor air. Results of the helium leak check are provided on the completed sub-slab soil gas sampling forms provided in **Appendix B**. Once the sample point was properly sealed and verified with a successful leak check, the sub-slab soil gas sample was collected over a five-minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and ASTM D-1946) and in a sorbent tube with a low flow air pump calibrated to collect one liter of soil gas over a five-minute period (TO-17). After the sample was collected, the hole was filled with Portland cement.

Indoor air, ambient air, and sub-slab soil gas samples were submitted to Eurofins Air Toxics, Inc. (Eurofins) of Folsom, CA for analysis of VOCs according to USEPA Method TO-15, naphthalene by TO-17, and methane by ASTM D-1946. Completed Air Sampling Forms are provided in **Appendix B.**

All Building 7 indoor air, ambient air, and sub-slab soil gas data was validated according to procedures provided in prior Work Plans and QAPPs.

2.3. Vapor Intrusion Investigation Sampling Results

One round of indoor air sampling was completed in Building 7 in May 2016. One round of indoor air and sub-slab soil gas sampling was completed in Building 7 in June 2016. The results of these sampling rounds are discussed below. **Table 1** presents the industrial sub-slab soil gas screening levels and the industrial indoor air screening levels used for comparative purposes in this vapor intrusion investigation report.

[4] The ambient air sample B7AA also served as an ambient air sample for the Building 15 vapor intrusion investigation.

2.3.1. Sub-slab

Validated analytical results for the June 2016 Building 7 sub-slab soil gas samples are provided in **Table 2**. Analytical results are provided for all TO-15 compounds, naphthalene by TO-17, and methane. The industrial sub-slab soil gas screening levels for all compounds, derived from the USEPA VISL Calculator (USEPA, 2016b), are also shown on **Table 2**. Concentrations that exceed the industrial sub-slab soil gas screening level are shaded. The distribution of selected compounds (those which have exceeded an industrial screening level in Building 7) in sub-slab soil gas samples is illustrated in **Figure 4**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

A number of compounds were detected in sub-slab soil gas samples collected beneath Building 7. A comparison of the industrial sub-slab soil gas screening levels to the sub-slab soil gas analytical results indicates no compounds were detected above their industrial sub-slab soil gas screening level.

Methane

Methane was detected in each sub-slab soil gas sample collected beneath Building 7. The concentrations of methane detected in the samples were at least three orders of magnitude less than 10% of the methane lower explosion limit (LEL) of 5% or 0.5%.

2.3.2. Indoor Air

Validated analytical results for the May and June 2016 Building 7 indoor air samples are provided in **Table 3**. Analytical results are provided for all TO-15 compounds, naphthalene by TO-17, and methane. The industrial indoor air screening levels for each compound, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 3**. Concentrations that exceed the industrial indoor air screening level are shaded. The distribution of selected compounds (those which have exceeded an industrial screening level in Building 7) in indoor air samples is illustrated in **Figure 5**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

A number of TO-15 and TO-17 compounds were detected in indoor air samples collected in Building 7 during the May and June 2016 sampling events. A comparison of the industrial indoor air screening levels to the indoor air analytical results indicates the following VOCs were detected above their industrial indoor air screening level:

- 1,2-Dichloroethane

- Chloroform
- Naphthalene

1,2-Dichloroethane

1,2-Dichloroethane was detected above its industrial indoor air screening level of 0.47 ug/m^3 at one sampling location (B7IA-3) in June 2016 at an estimated concentration of 0.49 J ug/m^3. There were no exceedances of 1,2 dichloroethane during the May 2016 sampling event.

Chloroform

Chloroform was detected at or above its industrial indoor air screening level of 0.53 ug/m^3 at four sampling locations (B7IA-1D, B7IA-2, B7IA-3, and B7IA-6) in May 2016 at estimated concentrations of 0.53 J, 0.72 J, 0.53 J, and 0.62 J ug/m^3, respectively. There were no exceedances of chloroform during the June 2016 sampling event.

Naphthalene

Naphthalene was detected above its industrial indoor air screening level of 0.36 ug/m^3 at one location by TO-17 in May 2016 (B7IA-2) at an estimated concentration of 0.37 J ug/m^3. Naphthalene was also detected above its industrial indoor air screening level at three locations by TO-15 in May 2016 (B7IA-A3, B7IA-5, and B7IA-6) at estimated concentrations of 0.41 J, 0.47 J, and 0.48 J ug/m^3 and at two locations in June 2016 (B7IA-5 and B7IA-6) at estimated concentrations of 0.45 J and 0.83 J ug/m^3, respectively.

Of the three compounds which exceed industrial indoor air screening levels, naphthalene was detected in sub-slab soil gas at two sampling locations (B7SS-2 and B7SS-5) by Method TO-17 at estimated concentrations of 1.2 J and 2 J ug/m^3, respectively. Chloroform was detected in sub-slab soil gas at one location (B7SS-6) at an estimated concentration of 4.6 J ug/m^3. For comparison purposes, the industrial soil gas screening levels for naphthalene and chloroform are 12 ug/m^3 and 18 ug/m^3, respectively. 1,2-Dichloroethane was not detected in sub-slab soil gas.

Methane

Methane was detected in each indoor air sample collected in Building 7. Methane was detected at concentrations a minimum of three orders of magnitude lower than 10% of the methane LEL of 5% or 0.5%.

2.3.3. Ambient Air

Validated analytical results for the ambient air samples collected during the May and June 2016 sampling rounds are provided in **Table 3**. For comparison purposes, the industrial indoor air screening levels are also provided in **Table 3**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Many of the compounds present in the ambient air samples were also detected in the sub-slab soil gas and indoor air samples collected during the Building 7 vapor intrusion investigation. Of the compounds detected in indoor air above their industrial indoor air screening levels, only naphthalene was detected in ambient air in June 2016 at estimated concentrations of 0.33 J (TO-15) and 0.032 J (TO-17) ug/m^3.

2.3.4. Recommended Path Forward for Building 7

The vapor intrusion pathway in Building 7 is considered a complete pathway based on the criteria provided in Section 1 as defined by the USEPA (USEPA, 2015a). No compounds were detected above the industrial sub-slab soil gas screening levels. Three compounds exceeded their industrial indoor air screening levels and are discussed below.

1,2-Dichloroethane

The results of the indoor air sampling conducted in June 2016 indicate that the concentration of 1,2-dichloroethane in one sample was detected above its industrial indoor air screening level (0.47 ug/m^3). The concentrations of 1,2-dichloroethane in all other June 2016 indoor air samples and all May 2016 indoor air samples were less than its industrial indoor air screening level. Since 1,2-dichloroethane was not detected in any of the sub-slab soil gas samples, it is unlikely that the presence of 1,2-dichloroethane in indoor air is associated with a subsurface source to indoor air.

Chloroform

Chloroform was detected in four of six indoor air samples collected in May 2016 at or above its industrial indoor air screening level (0.53 ug/m^3) at a maximum concentration of 0.72 ug/m^3. Chloroform was not detected above its industrial indoor air screening level in any samples collected in June 2016. Chloroform was not detected above its industrial sub-slab soil gas screening level. It is likely that chloroform exceedances are related to the extensive use (cafeteria) of publically-supplied water which has been found to contain elevated levels of chloroform in the past in Puerto Rico and use of bleach products, at a minimum. It is likely that the presence of chloroform in indoor air is associated with an indoor air background source.

Naphthalene

Naphthalene was detected at or above its industrial indoor air screening level (0.36 ug/^{3}) at three locations in May 2016 by Method TO-15 at estimated concentrations ranging from 0.41 J to 0.48 ug/m^3. Naphthalene was detected above its industrial indoor air screening level at two locations in June 2016 by Method TO-15 at estimated concentrations of 0.45 J and 0.83 J ug/m^3. The indoor air samples were also analyzed by TO-17, the preferred analytical method for determining low concentrations of naphthalene. Only one of the samples analyzed by Method TO-17 for naphthalene, with a concentration of 0.37 ug/m^3, exceeded the industrial indoor air screening level of 0.36 ug/m^3. Naphthalene was not detected above its industrial sub-slab soil gas screening level at any of the sub-slab sampling locations. Based on a review of all data, its presence in indoor air is likely related to an indoor air background source.

No additional vapor intrusion sampling is recommended at Building 7. The results of the Building 7 vapor intrusion investigation will be incorporated into the revised Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

3.0 Building 8 Vapor Intrusion Evaluation

3.1. Building 8 Area Site Description

Specific site characteristics important to the evaluation of the vapor intrusion pathway including a summary of previous subsurface investigations, building characteristics (including results from the indoor building surveys), and current and proposed building use are discussed below.

3.1.1. Hydrogeological Setting/Groundwater Impacts

Building 8 is located south of the Former Tank Farm (**Figure 2**). Groundwater monitoring data collected in the vicinity of Building 8 in 2016 indicated exceedances of the industrial groundwater concentrations for vapor intrusion screening levels for benzene, ethylbenzene, and xylene at monitoring well MW-5, which is located approximately 110 feet east of Building 8. A review of historic groundwater data collected at MW-5 indicated that benzene, ethylbenzene, xylene, methylene chloride, and MIBK exceeded their industrial groundwater concentrations for vapor intrusion.

3.1.2. Previous Vapor Intrusion Investigation Activities

Results of the Soil Vapor Investigation completed in Building 8 in 2012 were presented and discussed in the 2012 *Vapor Intrusion Investigation Report* (AMAI, 2012c). Findings of the *Vapor Intrusion Investigation Report* are summarized below.

- Four sub-slab soil gas samples were collected and analyzed for the five Former Tank Farm (FTF) COCs. The FTF COCs include acetone, chloromethane, methylene chloride, xylene, and MIBK.

- Acetone, chloromethane, methylene chloride, and xylene were detected in at least one sub-slab soil gas sample collected in Building 8. MIBK was not detected above the reporting limit in any of the sub-slab soil gas samples.

- All of the sub-slab soil gas concentrations for the Former Tank Farm COCs were less than the industrial sub-slab soil gas screening levels.

3.1.3. Building Characteristics and Uses

Building 8 is a 7,000 square foot single-story building (**Figure 6**). The floor of Building 8 consists of reinforced concrete supported by piling foundations and concrete footings. The thickness of the floor slab varies from six to 12 inches.

Building 8 is an active boiler house that contains two 600-horsepower boilers which provide steam to buildings throughout the facility via steam piping on the facility's central pipe rack. Until 2012, fuel oil was the primary fuel source for the boilers. In 2012, new boilers were installed that allow the use of propane or fuel oil. Propane has been the primary fuel source since the new boilers were installed. The building also contains equipment and processes to support the boilers including a water treatment system and an air compressor. In addition, the building contains an electrical room, control room, a small maintenance shop, a laboratory, and two offices. An emergency electrical generator is also located in Building 8. The control room in Building 8 is occupied 24 hours per day and seven days a week.

The central portion of the building (boiler room and water treatment system) is ventilated by exhaust fans. The HVAC system which serves the office space and the control room is located on the roof of Building 8. Building 8 was originally constructed in 1969 as a boiler house and its use since construction has not changed.

3.2. Vapor Intrusion Sampling and Analysis

A vapor intrusion investigation was conducted at Building 8 to assess the vapor intrusion pathway and to evaluate the potential health risk associated with the inhalation of indoor air. All sampling and analysis protocols were completed in accordance with prior USEPA approved Work Plans.

August 2015

An indoor building survey was conducted in Building 8 on August 28, 2015. A completed Building 8 Survey Form is provided in **Appendix A**. Results of the building survey identified the following building conditions:

- The HVAC system was operating;
- Potential indoor sources of VOCs were identified and are listed on the Building 8 Survey Form;
- Floor trenches and drains were located in the boiler room;
- No floor cracks were observed;
- Results of the PID screening for TVOC concentrations indicated the following:
    - TVOC concentrations in the breathing zone were non-detect throughout Building 8;
    - The TVOC concentrations at floor level were also non-detect throughout Building 8.

Two sub-slab soil gas samples (B8SSV-1 and B8SSV-2) were collected in Building 8 in August 2015. The sampling locations were selected based on the results from the earlier 2012 sub-slab soil gas investigation. A duplicate sub-slab soil gas sample (B8SSV-1D) was collected at B8SSV-1. Sub-slab soil gas sample locations are shown on **Figure 6**.[5] The samples were collected within portions of Building 8 where ventilation is provided by exhaust fans and air conditioning is not provided.

Prior to sampling, a 3/8-inch hole was drilled through the floor slab to approximately three inches below the floor slab. Teflon™-lined tubing was then inserted into the drill hole below the base of the floor slab. The annular space around the tubing was sealed using modeling clay and a helium leak check was completed to verify that the sub-slab soil gas sample point was properly sealed from indoor air. Results of the helium leak check are provided on the completed sub-slab soil gas sampling forms provided in **Appendix B**. Once the sample point was properly sealed and verified with a successful leak check, the sub-slab soil gas sample was collected over a five-minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and TO-3). Permanent sampling ports were then installed at the two sub-slab soil gas sample locations and a successful leak check was performed at each location.

Sub-slab soil gas samples were submitted to Accutest Laboratories (Accutest) of Dayton, New Jersey for analysis of the full TO-15 Target Compound List according to USEPA Method TO-15 and n-butane, methane, and propane by USEPA Method TO-3.[6] Completed Air Sampling Forms are provided in **Appendix B**.

<u>October 2015</u>

An indoor building survey was conducted in Building 8 on October 15, 2015 prior to completing the additional vapor intrusion sampling discussed below. A completed Building 8 Survey Form is provided in **Appendix A**. No changes in the building conditions were noted. Again, TVOC concentrations were non-detect.

Based on the results of the August 2015 sampling, an additional sub-slab sample (B8SSV-2), a co-located 24-hour indoor air sample (B8IA-2), and an ambient air sample (B8AA-1) were collected in October 2015. A duplicate sub-slab sample (B8SSV-2D) and a duplicate indoor air sample (B8IA-2D) were also collected. Sample locations are shown on **Figure 6**. The samples

[5] All duplicate samples for Building 8 were collected at sampling locations based on historical data.

[6] Due to concerns that an underground line may have been historically used for a brief period for supply of propane to Building 8, Method TO-3 was used to expand the compound list for this sampling event to include n-butane and propane as well as to assess the potential presence of methane.

were collected within a portion of Building 8 where ventilation is provided by exhaust fans and air conditioning is not provided.

Indoor air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946). Canisters were positioned such that the sample inlet was approximately four feet above the ground floor (e.g., to assess air quality in the breathing zone). One ambient air sample (B8 AA) was collected concurrently with the indoor air samples to establish outside background air quality conditions. Sample B8AA-1 was located approximately 100 feet upwind (east) of Building 8 (see **Figure 6**).

A sub-slab soil gas sample (B8SSV-2) and a duplicate sample (B8SSV-2D) were then collected at this sampling port location. Sub-slab soil gas samples were collected over a five-minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and ASTM D-1946).

Indoor air, ambient air, and sub-slab soil gas samples were submitted to Eurofins for analysis of VOCs according to USEPA Method TO-15 and methane by ASTM D-1946.[7] Completed Air Sampling Forms are provided in **Appendix B.**

All Building 8 indoor air, ambient air, and sub-slab soil gas data was validated according to procedures provided in prior Work Plans and QAPPs.

3.3. Vapor Intrusion Investigation Sampling Results

One round of sub-slab soil gas sampling was completed in Building 8 in August 2015. One round of indoor air and sub-slab soil gas sampling was completed in Building 8 in October 2015.[8] The results of these sampling rounds are discussed below.

3.3.1. Sub-slab

Validated analytical results for the August and October 2015 Building 8 sub-slab soil gas samples are provided in **Table 4**. Analytical results are provided for the Former Tank Farm Area COCs as well as other TO-15 compounds. The industrial sub-slab soil gas screening levels for the Former Tank Farm COCs and other TO-15 compounds, derived from the USEPA VISL

[7] Beginning in January 2016, analysis of naphthalene by Method TO-17 was incorporated into the vapor intrusion investigation program in order to address analysis of low level concentrations of naphthalene as discussed previously in this report.

[8] As noted in section 3.1.2, one round of sub-slab soil gas sampling was completed in Building 8 in 2012. Results of the 2012 sampling indicated levels of all Former Tank Farm Area COCs were either non-detect or present below their respective industrial sub-slab soil gas RSLs. Results of the 2012 sub-slab soil gas sampling in Building 8 are presented and discussed in the *Vapor Intrusion Investigation Report* that was submitted to the USEPA in 2012.

Calculator (USEPA, 2015b), are also shown on **Table 4**. Concentrations that exceed the industrial sub-slab soil gas screening level are shaded. The distribution of selected compounds in sub-slab soil gas samples is illustrated in **Figure 7**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Former Tank Farm Area COCs

Sampling results indicate the following Former Tank Farm Area COCs were detected in sub-slab soil gas samples including acetone, chloromethane, methylene chloride, and total xylenes. MIBK was not detected in any sub-slab soil gas sample.

A comparison of the industrial sub-slab soil gas screening levels to the sub-slab soil gas sampling results indicates that the concentrations of all Former Tank Farm COCs were below their industrial sub-slab soil gas screening levels.

Other TO-15 Compounds

The validated analytical results for other TO-15 compounds detected in sub-slab soil gas samples collected beneath Building 8 are provided in **Table 4**. The distribution of selected compounds in sub-slab soil gas samples collected beneath Building 8 is illustrated in **Figure 7**. A number of additional other TO-15 compounds were detected in sub-slab soil gas samples collected beneath Building 8.

A comparison of the industrial sub-slab soil gas screening levels to the sub-slab soil gas analytical results indicates that the concentrations of benzene, ethylbenzene, MTBE, and vinyl chloride exceeded their industrial sub-slab soil gas screening levels of 52 ug/m^3, 160 ug/m^3, 1,600 ug/m^3, and 93 ug/m^3 respectively at BBSSV-2 in August 2015 (MTBE at 1,910 ug/m^3 and vinyl chloride at 108 ug/m^3) and October 2015 (benzene at 64 J / 62 J ug/m^3, ethylbenzene at 220/230 ug/m^3, and vinyl chloride at 98 ug/m^3).

Methane

Methane was detected in each sub-slab soil gas sample collected in Building 8. Methane was detected in B8SSV-2 at concentrations greater than 10 % of the methane LEL of 5% or 0.5%, the industrial sub-slab soil gas screening level for methane. The detected concentrations of methane in sample B8SSV-2 in August 2015 (38 E %) and in October 2015 (59%) is greater than the upper explosive limit (UEL) of methane (15%), both of which are above the industrial sub-slab

soil gas screening level for methane. The concentration of methane detected in B8SSV-1 was one order of magnitude less than 10 percent of the methane LEL of 5% or 0.5%.

3.3.2. Indoor Air

Validated analytical results for the October 2015 Building 8 indoor air sample are provided in **Table 5**. Analytical results are provided for the Former Tank Farm Area COCs as well as other detected TO-15 compounds. The industrial indoor air screening levels for the Former Tank Farm COCs and other detected TO-15 compounds, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 5**. Concentrations that exceed the industrial indoor air screening level are shaded. The distribution of selected compounds detected in indoor air samples is illustrated in **Figure 8**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Former Tank Farm Area COCs

Sampling results indicate that all Former Tank Farm Area COCs were detected in B8IA-2 samples.

A comparison of the industrial indoor air screening levels to the indoor air sampling results indicates that the concentrations of all Former Tank Farm COCs were below their industrial indoor air screening levels.

Other TO-15 Compounds

The validated analytical results for other TO-15 compounds detected in the indoor air samples collected in Building 8 are provided in **Table 5**. The distribution of selected other TO-15 compounds in indoor air samples collected in Building 8 is illustrated in **Figure 8**. A number of additional other TO-15 compounds were detected in indoor air samples collected in Building 8. A comparison of the industrial indoor air screening levels to the indoor air analytical results indicates that no compounds were detected above their industrial indoor air screening levels.

Of the TO-15 compounds detected above industrial sub-slab soil gas screening levels in the co-located sub-slab sample (B8SSV-2), only benzene was detected in indoor air. Ethylbenzene, MTBE, and vinyl chloride were not detected in indoor air.

Methane

Methane was detected in the indoor air sample collected in Building 8. Methane was detected at a concentration of at least three orders of magnitude lower than 10 % of the methane LEL of 5% or 0.5%, the industrial indoor air screening level for methane.

3.3.3. Ambient Air

Validated analytical results for the ambient air samples collected during the October 2015 sampling round is provided in **Table 5**. For comparison purposes, the industrial indoor air screening levels are also provided in **Table 5**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Many of the compounds present in the ambient air samples were also detected in the sub-slab soil gas and indoor air samples collected during the Building 8 vapor intrusion investigation. As noted previously, no compounds were detected in indoor air in Building 8 above their industrial indoor air screening levels.

3.3.4. Recommended Path Forward for Building 8

The vapor intrusion pathway in Building 8 is considered a complete pathway based on the criteria provided in Section 1 as defined by the USEPA (USEPA, 2015a). The results of the Building 8 vapor intrusion investigation will be incorporated into the revised Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report. Due to the presence of multiple compounds exceeding the industrial sub-slab soil gas screening levels during multiple sampling events, including benzene, ethylbenzene, MTBE, vinyl chloride, and methane, additional sampling is warranted. Additional sub-slab soil gas and indoor air samples are scheduled to be collected in 4th Quarter 2016 / 1st Quarter 2017 and the results will be reported to USEPA in the RCRA Corrective Action Program Quarterly Progress Reports.

4.0 Building 15 Vapor Intrusion Evaluation

4.1. Building 15 Area Site Description

Specific site characteristics important to the evaluation of the vapor intrusion pathway including a summary of previous subsurface investigations, building characteristics (including results from the indoor building surveys), and current and proposed building use are discussed below.

4.1.1. Groundwater Impacts

Building 15 is located southeast of former Building 3 (**Figure 2**). Groundwater monitoring data collected in the vicinity of Building 15 in 2016 did not indicate any exceedances of the industrial groundwater concentrations for vapor intrusion screening levels. A review of limited historic groundwater data collected at monitoring well MW-11, located approximately 50 feet northeast of Building 15, did not indicate any exceedance of industrial groundwater concentrations for vapor intrusion. BMSMC conducted sampling of this building to understand if elevated levels of 1,4-dioxane were present in sub-slab soil gas directly above the heart of the on-site 1,4-dioxane plume.

4.1.2. Previous Vapor Intrusion Investigation Activities

No previous vapor intrusion investigation activities were conducted at Building 15.

4.1.3. Building Characteristics and Uses

Building 15 is a 1,436 square foot single-story building (**Figure 9**). The floor of Building 15 consists of reinforced concrete supported by concrete footings. The thickness of the floor slab is approximately 10 inches.

Building 15 currently contains the facility's security department. The building is divided into several rooms that contain offices, one meeting room, and a large room that contains computers and security camera displays. In addition, Building 15 contains an electrical room and a bathroom and an emergency electrical generator. The large room that contains computers and camera displays is occupied 24 hours per day and seven days a week. The offices are normally occupied during normal business hours, five days per week.

The HVAC system for the building consists of one roof mounted packaged air conditioning unit that serves the entire building.

Building 15 was originally constructed in the 1980s for the security department and its use since construction has not changed.

4.2. Vapor Intrusion Sampling and Analysis

A vapor intrusion investigation was conducted at Building 15 to assess if elevated levels of 1,4-dioxane are present in sub-slab soil gas beneath Building 15, which is located in a area where high concentrations of 1,4-dioxane are present in groundwater, and to preliminarily assess the vapor intrusion pathway and evaluate the potential health risk associated with the inhalation of indoor air. All sampling and analysis protocols were completed in accordance with prior USEPA approved Work Plans.

June 2015

An indoor building survey was conducted in Building 15 on June 10, 2016. A completed Building 15 Survey Form is provided in **Appendix A**. Results of the building survey identified the following building conditions:

- The HVAC system was operating;
- No potential indoor sources of VOCs were identified in Building 15;
- Floor drains were located in the bathroom;
- No floor cracks were observed;
- Results of the PID screening for TVOC concentrations indicated the following:
    - The TVOC concentration in the breathing zone ranged from 288-290 ppb.

One sub-slab soil gas sample (B15SS-1) was collected in Building 15 in June 2016. The sub-slab soil gas sample location is illustrated in **Figure 9**.[9] As Building 15 is occupied 24 hours per day and seven days per week, the HVAC system was operating during the collection of the sub-slab sample. As noted earlier, the June 2016 ambient air sample collected during the Building 7 vapor intrusion investigation also served as the Building 15 ambient air sample (see Section 2.2).

Prior to sampling, a 3/8-inch hole was drilled through the floor slab to approximately three inches below the floor slab. Teflon™-lined tubing was then inserted into the drill hole below the base of the floor slab. The annular space around the tubing was sealed using modeling clay and a helium leak check was completed to verify that the sub-slab soil gas sample point was properly sealed from indoor air. Results of the helium leak check are provided on the completed sub-slab soil gas sampling forms provided in **Appendix B**. Once the sample point was properly sealed and verified with a successful leak check, the sub-slab soil gas sample was collected over a five-

[9] No duplicate sample was collected at Building 15 as the requirements for duplicate samples were met by the collection of duplicates at Building 7 which were collected during the same period of time.

minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and ASTM D-1946) and in a sorbent tube with a low flow air pump calibrated to collect one liter of soil gas over a five-minute period (TO-17). After the sample was collected, the hole was filled with Portland cement.

The sub-slab soil gas sample was submitted to Eurofins for analysis of the full TO-15 Target Compound List according to USEPA Method TO-15, naphthalene by TO-17, and methane by ASTM D-1946. Completed Air Sampling Forms are provided in **Appendix B**.

The sub-slab soil gas data was validated according to procedures provided in prior Work Plans and QAPPs.

4.3. Vapor Intrusion Investigation Sampling Results

One sub-slab soil gas sample was collected beneath Building 15 in June 2016. The results of this sampling round are discussed below.

4.3.1. Sub-slab

Validated analytical results for the June 2016 Building 15 sub-slab soil gas sample are provided in **Table 6**. Analytical results are provided for all TO-15 compounds, naphthalene by TO-17, and methane. The industrial sub-slab soil gas screening levels for all compounds, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 6**. Concentrations that exceed the industrial sub-slab soil gas screening level are shaded. The concentration of 1,4-dioxane is also illustrated in **Figure 10**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

A number of compounds were detected in the sub-slab soil gas sample collected beneath Building 15. A comparison of the industrial soil gas screening levels to the sub-slab soil gas analytical results indicates no compounds were detected above their industrial sub-slab soil gas screening level. Although Building 15 is located in an area where high concentrations of 1,4-dioxane are present in groundwater, 1,4-dioxane was only detected in the sub-slab soil gas at an estimated concentration of 1.7 J ug/m^3, which is well below its industrial sub-slab soil gas screening level of 82 ug/m^3. The 1,4-dioxane sub-slab soil gas concentration under Building 15 (in the heart of the on-site 1,4-dioxane plume) was also below its residential sub-slab soil gas screening level (19 ug/m^3).

Methane

Methane was not detected in the sub-slab soil gas sample collected beneath Building 15.

4.3.2. Indoor Air

No indoor air samples were collected in Building 15.

4.3.3. Ambient Air

The ambient air sample collected in June 2015 as part of the Building 7 vapor intrusion investigation (B7AA), also served as the ambient air sample for Building 15. Many of the compounds present in the ambient air sample were also detected in the sub-slab soil gas sample collected at Building 15. As noted previously, no compounds were detected in sub-slab soil gas in Building 15 above their sub-slab soil gas screening levels.

4.3.4. Recommended Path Forward for Building 15

The vapor intrusion pathway in Building 15 has not been fully evaluated. One co-located sub-slab soil gas and indoor air sample will be collected at Building 15 in 4th Quarter 2016 / 1st Quarter 2017 to further evaluate vapor intrusion. The results will be reported to USEPA in the RCRA Corrective Action Program Quarterly Progress Reports and will also be incorporated into the Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

5.0 Building 18 Vapor Intrusion Evaluation

5.1. Building 18 Area Site Description

Specific site characteristics important to the evaluation of the vapor intrusion pathway including a summary of previous subsurface investigations, building characteristics (including results from the indoor building surveys), and current and proposed building use are discussed below.

5.1.1. Groundwater Impacts

Building 18 is located in the south/central part of the facility (**Figure 2**). Groundwater monitoring data collected in the vicinity of Building 18 in 2016 did not indicate any exceedances of the industrial groundwater concentrations for vapor intrusion screening levels. A review of historic groundwater data collected at monitoring well MW-38, located approximately 100 feet to the east of Building 18, did not indicate any exceedance of the industrial groundwater concentrations for vapor intrusion. BMSMC voluntarily conducted a vapor intrusion investigation at Building 18 as part of planned reconfiguration activities at Building 18, even though no recent or historical data triggered any requirements to conduct vapor intrusion sampling at this building.

5.1.2. Previous Vapor Intrusion Investigation Activities

No previous vapor intrusion investigation activities occurred at Building 18.

5.1.3. Building Characteristics and Uses

Building 18 is a 15,242 square foot single-story building (**Figure 11**). The floor of Building 18 consists of reinforced concrete supported by piling foundations and concrete footings. The thickness of the floor slab is approximately 10 inches.

Building 18 currently contains offices within large open rooms that contain office work stations/cubicles for the facility's engineering and technical services departments. The building also contains an electrical room, two bathrooms, and three meeting rooms. Building 18 is typically occupied during normal business hours, five days per week.

The HVAC system for the building consists of three roof mounted, packaged air conditioning units. Each unit services dedicated zones within the building.

Building 18 was originally constructed in 1988 for the primary purpose of providing analytical chemistry services to support Active Pharmaceutical Ingredient (API) manufacturing. When operated for this purpose, the building contained 11 separate analytical chemistry laboratories that provided both wet chemistry and organic testing services. In 2008, use of the building was

discontinued as part of a reconfiguration program at the site that consisted of the removal of API manufacturing and support infrastructure. The building remained unoccupied until it was renovated in 2012. Renovation of the building consisted of the removal of the analytical chemistry laboratories and construction of office space and office workstations where the laboratories were formerly located. Building 18's current use is offices and meeting rooms.

5.2. Vapor Intrusion Sampling and Analysis

A vapor intrusion investigation was conducted at Building 18 in July 2016 to assess the vapor intrusion pathway and to evaluate the potential health risk associated with the inhalation of indoor air. All sampling and analysis protocols were completed in accordance with prior USEPA approved Work Plans.

July 2016

An indoor building survey was conducted in Building 18 on July 8, 2016. A completed Building 18 Survey Form is provided in **Appendix A**. Results of the building survey identified the following building conditions:

- The HVAC system was operating;
- Potential indoor sources of VOCs were identified and are listed on the Building 18 Survey Form. These were removed prior to sampling;
- Floor drains were located in the restrooms and the janitor's closet;
- No floor cracks were observed;
- Results of the PID screening for TVOC concentrations during the actual sampling (HVAC off) indicated the following:
    - TVOC concentrations in the breathing zone were 143-199 ppb in Building 18.

Five sub-slab soil gas samples (B18SS-1 through B18SS-5), co-located indoor air samples (B18IA-1 through B18IA-5), and an ambient air sample (B18AA) were collected in Building 18 in July 2016. A duplicate sub-slab soil gas sample (B18SS-1D) and a duplicate indoor air sample (B18IA-1D) were also collected.[10] Sample locations are shown on **Figure 11**. The HVAC system was shut down for a period of 24 hours prior to the collection of the indoor air samples.

[10] The duplicate samples at Building 18 were selected based on close proximity to RA-10S / RA-10D where elevated concentrations of several compounds were detected in groundwater.

Indoor and ambient air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946) and a sorbent tube with a low flow air pump, programmed to pump 6 liters of air over a 24-hour period (TO-17). Canisters and sorbent tubes were positioned such that the sample inlet was approximately four feet above the ground floor (e.g., to assess air quality in the breathing zone). One ambient air sample (B18AA) was collected concurrently with the indoor air samples to establish outside background air quality conditions. Sample B18AA was located approximately 390 feet upwind (east) of Building 18 (see **Figure 11**).

Prior to sampling the sub-slab soil gas, a 3/8-inch hole was drilled through the floor slab to approximately three inches below the floor slab. Teflon™-lined tubing was then inserted into the drill hole below the base of the floor slab. The annular space around the tubing was sealed using modeling clay and a helium leak check was completed to verify that the sub-slab soil gas sample point was properly sealed from indoor air. Results of the helium leak check are provided on the completed sub-slab soil gas sampling forms provided in **Appendix B**. Once the sample point was properly sealed and verified with a successful leak check, the sub-slab soil gas sample was collected over a five-minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and ASTM D-1946) and in a sorbent tube with a low flow air pump calibrated to collect one liter of soil gas over a five-minute period (TO-17). After the sample was collected, the hole was filled with Portland cement.

Indoor air, ambient air, and sub-slab soil gas samples were submitted to Eurofins for analysis of VOCs according to USEPA Method TO-15, naphthalene by TO-17, and methane by ASTM D-1946. Completed Air Sampling Forms are provided in **Appendix B**.

All Building 18 indoor air, ambient air, and sub-slab soil gas data was validated according to procedures provided in prior Work Plans and QAPPs.

5.3. Vapor Intrusion Investigation Sampling Results

One round of indoor air and sub-slab soil gas sampling was completed in Building 18 in July 2016. The results of this sampling round are discussed below.

5.3.1. Sub-slab

Validated analytical results for the July 2016 Building 18 sub-slab soil gas samples are provided in **Table 7**. Analytical results are provided for all TO-15 compounds, naphthalene by TO-17, and methane. The industrial soil gas screening levels for all compounds, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 7**. Concentrations that exceed the industrial sub-slab soil gas screening level are shaded. The distribution of selected

compounds (those which have exceeded an industrial screening level in Building 18) in sub-slab soil gas samples is illustrated in **Figure 12**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

A number of compounds were detected in sub-slab soil gas samples collected beneath Building 18. A comparison of the industrial sub-slab soil gas screening levels to the sub-slab soil gas analytical results indicates that naphthalene by TO-17 was detected at a concentration equal to its industrial sub-slab soil gas screening level of 12 ug/m^3 at one location (B18SS-3). No other compounds exceeded their industrial sub-slab soil gas screening levels.

Methane

Methane was detected in each sub-slab soil gas sample collected beneath Building 18. The concentrations of methane detected in the samples were at least three orders of magnitude less than 10 % of the methane LEL of 5% or 0.5%.

5.3.2. Indoor Air

Validated analytical results for the July 2016 Building 18 indoor air samples are provided in **Table 8**. Analytical results are provided for all TO-15 compounds, naphthalene by TO-17, and methane. The industrial indoor air screening levels for each compound, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 8**. Concentrations that exceed the industrial indoor air screening level are shaded. The distribution of selected compounds (those which have exceeded an industrial screening level in Building 18) in indoor air samples is illustrated in **Figure 13**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

A number of TO-15 and T0-17 compounds were detected in indoor air samples collected in Building 18 during the July 2016 sampling event. A comparison of the industrial indoor air screening levels to the indoor air analytical results indicates the following VOCs were detected above their industrial indoor air screening level:

- 1,2-Dichloroethane
- Trichloroethene
- Naphthalene

1,2-Dichloroethane

1,2-Dichloroethane was detected above its industrial indoor air screening level of 0.47 ug/m^3 at all five sampling locations (B18IA-1 through B18IA-5) in July 2016 at concentrations ranging from 1.5 to 5 ug/m^3.

Trichloroethene

Trichloroethene was detected at or above its industrial indoor air screening level of 3 ug/m^3 at two sampling locations (B18IA-1 and B18IA-4) in July 2016 at concentrations of 3.2 and 3.6 ug/m^3, respectively. Trichloroethene was detected at a concentration of 2.9 ug/m^3 (duplicate sample B18IA-1D), slightly below its industrial indoor air screening level.

Naphthalene

Naphthalene was detected above its industrial indoor air screening level of 0.36 ug/m^3 at one location by TO-17 in July 2016 (B187IA-5) at a concentration of 0.39 ug/m^3. Naphthalene was not detected above its industrial indoor air screening level at any location by TO-15.

1,2-Dichloroethane was detected in sub-slab soil gas at one location (B187SS-1) at an estimated concentration of 1.1 J ug/m^3. Trichloroethene was not detected in sub-slab soil gas at any location above (or below) its reporting limit of 6.3 to 6.6 ug/m^3. Naphthalene was detected in sub-slab soil gas at all five sub-slab sampling locations by Method TO-17 at concentrations ranging from 1.4 to 12 ug/m^3 and at four locations by TO-15 at estimated concentrations ranging from 0.58 J to 4 J ug/m^3. For comparison purposes, the industrial sub-slab soil gas screening levels for 1,2 dichloroethane, trichloroethene, and naphthalene are 16 ug/m^3, 100 ug/m^3, and 12 ug/m^3 respectively.

Methane

Methane was detected in each indoor air sample collected in Building 18. Methane was detected at concentrations a minimum of three orders of magnitude lower than 10 % of the methane LEL of 5% or 0.5%.

5.3.3. Ambient Air

Validated analytical results for the ambient air samples collected during the May and June 2016 sampling rounds are provided in **Table 8**. For comparison purposes, the industrial indoor air screening levels are also provided in **Table 8**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Many of the compounds present in the ambient air sample were also detected in the indoor air samples collected during the Building 18 vapor intrusion investigation. Of the compounds detected in indoor air above their industrial indoor air screening levels, only naphthalene was detected in ambient air in July 2016 at an estimated concentration of 0.12 J ug/m^3 (TO-15).

5.3.4. Recommended Path Forward for Building 18

The vapor intrusion pathway in Building 18 is considered a complete pathway based on the criteria provided in Section 1 as defined by the USEPA (USEPA, 2015a). Based on the results of the July 2016 sampling at Building 18, naphthalene equals its industrial sub-slab soil gas screening level and 1,2 dichloroethane, trichloroethene, and naphthalene exceed their industrial indoor air screening levels. A second sub-slab soil gas and indoor air sampling event will be conducted in 4^{th} Quarter 2016 / 1^{st} Quarter 2017. The results will be reported to USEPA in the RCRA Corrective Action Program Quarterly Progress Reports and will also be incorporated into the Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

6.0 Building 30 Vapor Intrusion Evaluation

6.1. Building 30 Area Site Description

Specific site characteristics important to the evaluation of the vapor intrusion pathway including a summary of previous subsurface investigations, building characteristics (including results from the indoor building surveys), and current and proposed building use are discussed below.

6.1.1. Groundwater Impacts

Building 30 is located east of the Brule Area and northwest of Building 5 (**Figure 2**). Groundwater monitoring data collected in the vicinity of Building 30 in 2016 indicated exceedances of the industrial groundwater concentrations for vapor intrusion screening level for ethylbenzene at RA-19. A review of historic groundwater data collected at monitoring well UP-1, located 100 feet east of Building 30, and direct push groundwater samples collected adjacent to Building 30, indicated that benzene, ethylbenzene, and xylene exceeded their industrial groundwater concentrations for vapor intrusion.

6.1.2. Previous Vapor Intrusion Investigation Activities

No previous vapor intrusion investigation activities were conducted at Building 30.

6.1.3. Building Characteristics and Uses

Building 30 is a 13,509 square foot two-story building (**Figure 14**). The floor of Building 30 consists of reinforced concrete supported by piling foundations and concrete footings. The thickness of the floor slab is approximately 10 inches.

Building 30 currently contains offices, large open rooms that contain office workstations / cubicles for the facility's maintenance and environmental, health and safety departments. The first floor of the building also contains an electrical room, two bathrooms, and three meeting rooms. The second floor of Building 30 consists of a mezzanine on the north half of the building and contains a record storage room, an office workstation area, and two bathrooms. The building is normally occupied during normal business hours, five days per week.

The HVAC system for the building consists of two packaged air conditioning units located on concrete pads on the west side of the building and a mobile type air conditioner that serves a single room. Each of the two packaged air conditioning units services dedicated zones within the building.

Building 30 was originally constructed in 1984 for the primary purpose of Finished Pharmaceutical Product (FPP) manufacturing. When operated for this purpose, the building contained 2 tableting production lines that spanned most of the building's interior. In 2005, the building was renovated. Renovation of the building consisted of the removal of the FPP manufacturing and construction of office space and office workstations where the tableting lines were formerly located.

6.2. Vapor Intrusion Sampling and Analysis

A vapor intrusion investigation was conducted at Building 30 to assess the vapor intrusion pathway and to evaluate the potential health risk associated with the inhalation of indoor air in October 2015, January 2016, May 2016, and July 2016. All sampling and analysis protocols were completed in accordance with prior USEPA approved Work Plans.

October 2015

An indoor building survey was conducted in Building 30 on October 15, 2015. A completed Building 30 Survey Form is provided in **Appendix A**. Results of the building survey identified the following building conditions:

- The HVAC system was operating;
- Potential indoor sources of VOCs were identified and are listed on the Building 30 Survey Form;
- Floor drains were located in the restrooms and janitor's closet;
- Results of the PID screening for TVOC concentrations during the actual sampling (HVAC off) indicated the following:
    - TVOC concentrations in the breathing zone were non-detect throughout Building 30
    - The TVOC concentrations at floor level were also non-detect.

Five sub-slab soil gas samples (B30SSV-1 through B30SSV-5), co-located indoor air samples (B30IA-1 through B30IA-5), and an ambient air sample (B30/42AA) were collected in Building 30 in October 2015. A duplicate sub-slab soil gas sample (B30SS-4D) and a duplicate indoor air sample (B30IA-4D) were also collected. Sample locations are shown on **Figure 14**.[11] The

[11] With the exception of the October 2015 duplicate samples for Building 30 which were collected at random sample locations, all other duplicate sampling locations were selected based on historical sampling data.

HVAC system was shut down for a period of 24 hours prior to the collection of the indoor air samples.

Indoor and ambient air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946). Canisters were positioned such that the sample inlet was approximately four feet above the ground floor (e.g., to assess air quality in the breathing zone). One ambient air sample (B30/42AA) was collected concurrently with the indoor air samples to establish outside background air quality conditions. Sample B30/42AA was located approximately 615 feet upwind (east) of Building 30 (see **Figure 14**).

Prior to sub-slab soil gas sampling, a 3/8-inch hole was drilled through the floor slab to approximately three inches below the floor slab. Teflon™-lined tubing was then inserted into the drill hole below the base of the floor slab. The annular space around the tubing was sealed using modeling clay and a helium leak check was completed to verify that the sub-slab soil gas sample point was properly sealed from indoor air. Results of the helium leak check are provided on the completed sub-slab soil gas sampling forms provided in **Appendix B**. Once the sample point was properly sealed and verified with a successful leak check, the sub-slab soil gas sample was collected over a five-minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and ASTM D-1946). Permanent sampling ports were then installed at each of the five sub-slab soil gas sample locations and a successful leak check was performed at each location.

Sub-slab soil gas samples were originally collected on October 9th and 10th, but due to laboratory error these samples were not analyzed by TO-15.[12] Sub-slab soil gas was resampled in four locations (B30SSV-1 through B30SSV-4) on October 27th and 28th. A sub-slab soil gas sample was unable to be collected from B30SSV-5 due to the apparent presence of perched water in the subsurface soil.

Indoor air, ambient air, and sub-slab soil gas samples were submitted to Eurofins for analysis of VOCs according to USEPA Method TO-15 and methane according to ASTM D-1946. Completed Air Sampling Forms are provided in **Appendix B**.

<u>January 2016</u>

An indoor building survey was conducted in Building 30 on January 29, 2016 prior to completing the additional vapor intrusion sampling discussed below. A completed Building 30

[12] Methanol and methane results for these samples were reported by the laboratory.

Survey Form is provided in **Appendix A**. No changes in the building conditions were noted. TVOC concentrations ranged from non-detect to 10 ppb.

Based on the results of the October 2015 sampling, an additional round of sub-slab soil gas samples (B30SSV-1 through B30SSV-5), co-located indoor air samples (B30IA-1 through B30IA-5), and an ambient air sample (B30/42AA) were collected in January 2016. A duplicate sub-slab soil gas sample (B30SS-4D) and a duplicate indoor air sample (B30IA-4D) were also collected. Sample locations are shown on **Figure 14**. The HVAC system was shut down for a period of 24 hours prior to the collection of the sub-slab and indoor air samples.

Indoor and ambient air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946) and a sorbent tube with a low flow air pump, programmed to pump 6 liters of air over a 24-hour period (TO-17). Canisters and sorbent tubes were positioned such that the sample inlet was approximately four feet above the ground floor. One ambient air sample (B30/42AA) was collected concurrently with the indoor air samples to establish outside background air quality conditions. Sample B30/42AA was located approximately 615 feet upwind (east) of Building 30 (see **Figure 14**).

Sub-slab soil gas samples (B30SSV-1 through B30SSV-5) and a duplicate sample (B30SSV-4D) were then collected at the sampling port locations. The sub-slab soil gas samples were collected over a five-minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and ASTM D-1946) and in a sorbent tube with a low flow air pump calibrated to collect one liter of soil gas over a five-minute period (TO-17).

Indoor air, ambient air, and sub-slab soil gas samples were submitted to Eurofins for analysis of VOCs according to USEPA Method TO-15, naphthalene by TO-17, and methane by ASTM D-1946. Due to elevated detection limits during the October 2015 sampling event, sample B30SSV-1 was also analyzed for the full suite of compounds by TO-17. Completed Air Sampling Forms are provided in **Appendix B.**

May 2016

Due to the presence of naphthalene in several indoor air samples, BMSMC deployed five AllerAir air purification (carbon) portable units in Building 30, as described in greater detail in **Section 6.3.4**. In order to evaluate the effectiveness of the systems, an indoor air sampling event was conducted in May 2016. An indoor building survey was conducted in Building 30 on May 29th prior to completing the additional vapor intrusion sampling discussed below. A completed Building 30 Survey Form is provided in **Appendix A**. No changes in the building conditions were noted. TVOC concentrations were non-detect.

An additional round of indoor air samples (B30IA-1 through B30IA-5) and an ambient air sample (B30/42AA) were collected in May 2016. A duplicate indoor air sample (B30IA-1D) was also collected. Sample locations are shown on **Figure 14**. The AllerAir carbon units were turned off 24 hours prior to the sampling. The HVAC system was also shut down for a period of 24 hours prior to the collection of the indoor air samples.

Indoor and ambient air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946) and a sorbent tube with a low flow air pump, programmed to pump 6 liters of air over a 24-hour period (TO-17). Canisters and sorbent tubes were positioned such that the sample inlet was approximately four feet above the ground floor. One ambient air sample (B30/42AA) was collected concurrently with the indoor air samples to establish outside background air quality conditions. Sample B30/42AA was located approximately 615 feet upwind (east) of Building 30 (see **Figure 14**).

Indoor air and ambient air samples were submitted to Eurofins for analysis of VOCs according to USEPA Method TO-15, naphthalene by TO-17, and methane by ASTM D-1946. Completed Air Sampling Forms are provided in **Appendix B.**

<u>July 2016</u>

A second confirmatory sampling event was conducted in July 2016. An indoor building survey was conducted in Building 30 on July 8, 2016 prior to completing the additional vapor intrusion sampling discussed below. A completed Building 30 Survey Form is provided in **Appendix A**. No changes in the building conditions were noted. TVOC concentrations were non-detect.

Based on the results of the May 2016 sampling, an additional indoor air sample (B30IA-1) was collected in July 2016. The sample location is illustrated in **Figure 14**. The AllerAir air purification (carbon) portable units were turned off 24 hours prior to the sampling. The HVAC system was also shut down for a period of 24 hours prior to the collection of the indoor air sample.

The indoor air sample was collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946) and a sorbent tube with a low flow air pump, programmed to pump 6 liters of air over a 24-hour period (TO-17). Canisters and sorbent tubes were positioned such that the sample inlet was approximately four feet above the ground floor. The ambient air sample collected in July 2016 as part of the Building 18 vapor intrusion investigation (B18AA), also served as the ambient air sample for Building 30 (see **Figure 11**).

Indoor air and ambient air samples were submitted to Eurofins for analysis of VOCs according to USEPA Method TO-15, naphthalene by TO-17, and methane by ASTM D-1946. Completed Air Sampling Forms are provided in **Appendix B.**

All Building 30 indoor air, ambient air, and sub-slab soil gas data was validated according to procedures provided in prior Work Plans and QAPPs.

6.3. Vapor Intrusion Investigation Sampling Results

Two rounds of indoor air and sub-slab soil gas sampling were completed in Building 30 in October 2015 and January 2016. One round of indoor air sampling was completed in Building 30 in May 2016. One additional indoor air sample was collected in July 2016. The results of these sampling rounds are discussed below.

6.3.1. Sub-slab

Validated analytical results for the October 2015 and January 2016 Building 30 sub-slab soil gas samples are provided in **Table 9**. Analytical results are provided for the Building 5 Area COCs as well as other TO-15 compounds, other TO-17 compounds, and methane. The industrial sub-slab soil gas screening levels for the Building 5 Area COCs and other compounds, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 9**. Concentrations that exceed the industrial sub-slab soil gas screening level are shaded. The distribution of selected compounds (Building 5 Area COCs and any compound which exceeded an industrial screening level in Building 30) in sub-slab soil gas samples is illustrated in **Figure 15**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Building 5 Area COCs

Sampling results indicate the following Building 5 Area COCs were detected in multiple sub-slab soil gas samples during the October 2015 and January 2016 events, including benzene, ethylbenzene, toluene, total xylenes, acetone, MIBK, and isopropyl alcohol. Methanol was not detected in any sub-slab soil gas sample.

A comparison of the industrial sub-slab soil gas screening levels to the sub-slab soil gas sampling results indicates that the concentrations of benzene, ethylbenzene, and total xylenes exceeded their industrial sub-slab soil gas screening levels of 52 $\mu g/m^3$, 160 $\mu g/m^3$, and 15,000 $\mu g/m^3$, respectively at B30SSV-1 at estimated concentrations of 1,700 J, 280,000, and 3,059,000 ug/m^3 respectively in October 2015 (TO-15), and at concentrations of 680, 6,200 EJ, and 97,600 SJ ug/m^3 respectively in January 2016 (TO-17). In January 2016, ethylbenzene (61,000 ug/m^3)

and xylene (1,936,000 ug/m^3) also exceeded their sub-slab soil gas screening levels when analyzed by TO-15. The concentration of benzene exceeded its industrial sub-slab soil gas screening level at sampling location B30SSV-2 at a concentration of 190 ug/m^3 in October 2015 (TO-15). Overall, concentrations of benzene, ethylbenzene, and total xylenes were highest in the southwest quadrant (B30SSV-1) and concentrations decreased by several orders of magnitude in samples collected elsewhere in Building 30.

Other TO-15 and TO-17 Compounds

The validated analytical results for other TO-15 and TO-17 compounds detected in sub-slab soil gas samples collected beneath Building 30 are provided in **Table 9**. The distribution of selected compounds (those which exceeded an industrial screening level in Building 30) in sub-slab soil gas samples collected beneath Building 30 is illustrated in **Figure 15**. A number of additional other TO-15 and TO-17 compounds were detected in sub-slab soil gas samples collected beneath Building 30. A comparison of the industrial sub-slab soil gas screening levels to the sub-slab soil gas analytical results indicates that only vinyl chloride was detected above its industrial sub-slab soil gas screening level (93 ug/m^3) at sample location B30SSV-1 in January 2016 at a concentration of 170 ug/m^3 (TO-17).

Methane

Methane was detected in each sub-slab soil gas sample collected in Building 30. Methane was detected in B30SSV-1 (9.3%) at concentrations greater than 10 % of the methane LEL of 5% or 0.5%, the industrial sub-slab soil gas screening level for methane. The detected concentrations of methane in sample B30SSV-1 in October 2015 (9.3%) was less than the upper explosive limit (UEL) of methane (15%). In January 2016, the methane concentration detected in B30SSV-1 (48%) was greater than the UEL. The concentration of methane detected in all other samples was less than 10 percent of the methane LEL of 5% or 0.5%.

6.3.2. Indoor Air

Validated analytical results for the October 2015, January 2016, May 2016, and July 2016 Building 30 indoor air sample events are provided in **Table 10**. Analytical results are provided for the Building 5 Area COCs as well as other TO-15 compounds, naphthalene by TO-17, and methane. The industrial indoor air screening levels for the Building 5 Area COCs and other compounds, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 10**. Concentrations that exceed the industrial indoor air screening level are shaded. The distribution of selected compounds (Building 5 Area COCs and any compound which exceeded an industrial screening level in Building 30) in indoor air samples is illustrated in **Figure 16**.

Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Building 5 Area COCs

Sampling results indicate the following Building 5 Area COCs were detected in multiple indoor air samples during the October 2015, January 2016, May 2016, and July 2016 sampling events including benzene, ethylbenzene, toluene, total xylenes, acetone, MIBK, and isopropyl alcohol. Methanol was not detected in any indoor air soil gas sample.

A comparison of the industrial indoor air screening levels to the indoor air sampling results indicates that ethylbenzene was detected at its industrial indoor air screening level (4.9 µg/m^3) in B30IA-1 in October 2015. All other ethylbenzene sample results were below the industrial indoor air screening level. All other Building 5 Area COCs were below their respective industrial indoor air screening level.

Other TO-15 Compounds

The validated analytical results for other TO-15 compounds in the indoor air samples collected in Building 30 are provided in **Table 10**. The distribution of select other TO-15 compounds (those which exceeded an industrial screening level in Building 30) in indoor air samples collected in Building 30 is illustrated in **Figure 16**. A number of additional other TO-15 compounds were detected in indoor air samples collected in Building 30. A comparison of the industrial indoor air screening levels to the indoor air analytical results indicates the following VOCs were detected above their indoor air screening level:

- 1,2-Dichloroethane
- 1,2-Dichloropropane
- Naphthalene

1,2-Dichloroethane

1,2-Dichloroethane was detected above its industrial indoor air screening level (0.47 µg/m^3) in the southeast quadrant (B30IA-2) at an estimated concentration of 0.52 J µg/m^3 during the May 2016 sampling round. It was not detected during any other sampling event.

1,2-Dichloropropane

1,2-Dichloropropane was detected above its industrial indoor air screening level (1.2 μg/m^3) in the southwest quadrant (B30IA-1) at 3.3 μg/m^3 during the October 2015 sampling round. It was not detected during any other sampling event.

Naphthalene

Naphthalene was detected above its industrial indoor air screening level (0.36 μg/m^3) in the southwest quadrant (B30IA-1) at 0.54 μg/m^3 by TO-17 during the January 2016 sampling round and at an estimated concentration of 0.64 J μg/m^3 by TO-15 during the May 2016 sampling round. Naphthalene was also detected above its industrial indoor air screening level in the northwest quadrant (B30IA-4/4D) at 2.6 JJ μg/m^3 (duplicate sample 1.6 J μg/m^3) by TO-15 during the October 2015 sampling round. All compounds were below their respective industrial indoor air screening levels in the July 2016 sample.

1,2-Dichloroethane and 1,2-dichloropropane were not detected in sub-slab soil gas at any location above (or below) their industrial sub-slab soil gas screening levels of 16 ug/m3 and 41 ug/m^3, respectively. Naphthalene was detected in sub-slab soil gas at two sampling locations, including B30SSV-1 by TO-17 in January 2016 at an estimated concentration of 1.5 J ug/m^3 and B30SSV-4 by TO-15 in October 2015 at an estimated concentration of 0.36 JJ / 0.3 JJ ug/m^3, below its industrial soil gas screening level of 12 ug/m^3.

Methane

Methane was detected in each indoor air sample collected in Building 30. Methane was detected at concentrations a minimum of three orders of magnitude lower than 10 % of the methane LEL of 5% or .5%.

Confirmatory Samples

Confirmatory samples were collected in May and July 2016 to evaluate the effectiveness of the AllerAir air purification units (see Section 6.3.4). In May 2016, naphthalene was detected above its industrial indoor air screening level of 0.36 ug/m^3 at one location (B30IA-1) at an estimated concentration of 0.64 J ug/m^3 (TO-15) in the duplicate sample. The initial sample was below the industrial indoor air screening level, with an estimated concentration of 0.23 J ug/m^3. The two TO-17 samples at this location detected naphthalene at concentrations of 0.078 and 0.087 ug/m^3, both below the 0.36 ug/m^3 industrial indoor air screening level. B30IA-1 was resampled in July 2016, with the concentration of the TO-15 sample reported at <4.3 ug/m^3 and the TO-17 sample

reported at 0.087 ug/m^3. In addition, in May 2016 1,2-dichloroethane was detected above its industrial indoor air screening level of 0.47 ug/m^3 at one location (B30IA-2) at an estimated concentration of 0.52 J ug/m^3. This compound was not detected above the industrial indoor air screening level in any sample collected during any of the other sampling events and 1,2-dichloroethane is a common indoor air contaminant.

6.3.3. Ambient Air

Validated analytical results for the ambient air samples collected during the October 2015 and January, May, and July 2016 sampling rounds are provided in **Table 10**. For comparison purposes, the industrial indoor air screening levels are also provided in **Table 10**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Many of the compounds present in the ambient air samples were also detected in the indoor air samples collected during the Building 30 vapor intrusion investigation. Of the compounds detected in indoor air above their industrial indoor air screening levels, ethylbenzene was detected in ambient air in October 2015 at an estimated concentration of 0.36 J ug/m^3 and naphthalene was detected in ambient air in May 2016 at an estimated concentration of 0.25 J ug/m^3 (TO-15).

6.3.4. Aller Air Carbon Filters

Based on the results of the vapor intrusion sampling activities conducted at Building 30 as discussed in Section 6.3, BMSMC deployed five AllerAir Model AirMedic Pro 6 portable VOC air purification (carbon) units on April 26, 2016 at the following locations:

Area Name	Room Number
Offices of D. Medina	147/148
MT Conf. Room	145
Facilities/Eng. Conf. Room	108
Central Work Stations Area	111
QC/Valid. Work Station Area	139

Each of the five units has the following components:

- Variable speed fan with a maximum flow setting of 400 cubic feet per minute;
- Pre-filter for large particulate removal;
- High efficiency particulate air (HEPA) filter capable of removal fine particulate; and

- Activated carbon filter with 36 pounds of activated carbon for removal of organic compounds.

BMSMC operates the units 24 hours per day, 7 days per week. Since the HVAC systems operate with recirculation of the indoor air, the five units are treating air recirculated throughout the building.

To ensure the units are properly operating, BMSMC has established an inspection and maintenance program for the units. The inspection program consists of a weekly inspection of the unit to verify that the unit is operational and is operating at the recommended flow speed setting. Maintenance of the units consists of the periodic replacement of the filters. Based on the manufacturer's recommendations, the filter replacement program consists of:

- Pre-filter replacement or vacuum once every three months;
- HEPA filter replacement once every three years at a minimum; and
- Activated carbon filter replacement once every two years at a minimum.

6.3.5. Recommended Path Forward for Building 30

The vapor intrusion pathway in Building 30 is considered a complete pathway based on the criteria provided in Section 1 as defined by the USEPA (USEPA, 2015a). Due to the presence of naphthalene in several indoor air samples, BMSMC installed five AllerAir air purification (carbon) portable units in Building 30. Based on the results of confirmatory indoor air samples collected in May and July 2016, the AllerAir units have performed as designed. Confirmatory samples will be collected semi-annually over the next year (December 2016 and June 2017) and the results will be reported to USEPA in the RCRA Corrective Action Program Quarterly Progress Reports. All results of the Building 30 vapor intrusion investigation will be incorporated into the revised Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

7.0 Building 42 Vapor Intrusion Evaluation

7.1. Building 42 Area Site Description

Specific site characteristics important to the evaluation of the vapor intrusion pathway including a summary of previous subsurface investigations, building characteristics (including results from the indoor building surveys), and current and proposed building use are discussed below.

7.1.1. Groundwater Impacts

Building 42 is located north of Building 5 (**Figure 2**). Groundwater monitoring data collected in the vicinity of Building 42 in 2016 did not indicate any exceedances of the industrial groundwater concentrations for vapor intrusion screening levels. A review of historic groundwater data collected at monitoring well UP-1, located approximately 110 feet to the southwest of building 42, indicated that benzene and ethylbenzene exceeded their industrial groundwater concentrations for vapor intrusion.

7.1.2. Previous Vapor Intrusion Investigation Activities

No previous vapor intrusion investigation activities were conducted at Building 42.

7.1.3. Building Characteristics and Uses

Building 42 is a 6,978 square foot single-story building (**Figure 17**). The floor of Building 42 consists of reinforced concrete supported by concrete footings. The thickness of the floor slab is approximately 10 inches.

Building 42 currently contains the facility's maintenance department. The building is divided into several rooms that contain offices, two bathrooms, an instrumentation maintenance room, large rooms that contain equipment and maintenance supplies such as paints, and a loading dock. The building is normally occupied 24 hours per day and 7 days per week.

The HVAC system for the building consists of one roof mounted air conditioning unit and a packaged air conditioning unit installed on a concrete pad located on the south side of the building. The roof mounted air conditioning unit services the instrumentation maintenance room and the packaged air conditioning unit services office spaces. The large loading dock area is not air conditioned and ventilation is provided by exhaust fans.

Building 42 was originally constructed in 1994 as a solvent drum storage warehouse. In 2007 the use of the building for drum storage was discontinued and the building was renovated to serve its current use for maintenance activities and equipment storage.

7.2. Vapor Intrusion Sampling and Analysis

A vapor intrusion investigation was conducted at Building 42 to assess the vapor intrusion pathway and to evaluate the potential health risk associated with the inhalation of indoor air in October 2015 and January 2016. All sampling and analysis protocols were completed in accordance with prior USEPA approved Work Plans.

October 2015

An indoor building survey was conducted in Building 42 on October 15, 2015. A completed Building 42 Survey Form is provided in **Appendix A**.[13] Results of the building survey identified the following building conditions:

- The HVAC system was operating;
- Potential indoor sources of VOCs were identified and are listed on the Building 42 Survey Form;
- Floor trenches are located in maintenance and storage areas;
- Floor drains are located in locker rooms;
- No floor cracks were observed;
- Results of the PID screening (HVAC on) for TVOC concentrations indicated the following:
    - TVOC concentrations in the breathing zone were non-detect throughout Building 42
    - The TVOC concentrations at floor level were also non-detect.

Three sub-slab soil gas samples (B42SSV-1 through B42SSV-3), three co-located indoor air samples (B42IA-1 through B42IA-3), and an ambient air sample (B30/42AA) were collected in October 2015. Sample locations are shown on **Figure 17**.[14] As Building 42 is occupied 24 hours per day and seven days per week, and due to its importance for operation of the facility

[13] Given the large scale storage of maintenance supplies and equipment in Building 42, photo documentation is also included for this building in Appendix A.

[14] No duplicate samples were as collected at Building 42 during the October 2015 sampling as the requirements for duplicate samples were met by the collection of duplicates at Building 30 which were collected during the same period of time.

including instrument testing and maintenance activities, the HVAC systems were operating during the collection of the sub-slab and indoor air samples from those areas.

Indoor and ambient air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946). Canisters were positioned such that the sample inlet was approximately four feet above the ground floor (e.g., to assess air quality in the breathing zone). One ambient air sample (B30/42AA) was collected in Building 42 concurrently with the indoor air samples to establish outside background air quality conditions. Sample B30/42AA was located approximately 500 feet upwind (east) of Building 42 (see **Figure 17**).

Prior to sub-slab soil gas sampling, a 3/8-inch hole was drilled through the floor slab to approximately three inches below the floor slab. Teflon™-lined tubing was then inserted into the drill hole below the base of the floor slab. The annular space around the tubing was sealed using modeling clay and a helium leak check was completed to verify that the sub-slab soil gas sample point was properly sealed from indoor air. Results of the helium leak check are provided on the completed sub-slab soil gas sampling forms provided in **Appendix B**. Once the sample point was properly sealed and verified with a successful leak check, the sub-slab soil gas sample was collected over a five-minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and ASTM D-1946). Permanent sampling ports were then installed at each of the three sub-slab soil gas sample locations and a successful leak check was performed at each location.

Indoor air, and ambient air, and sub-slab soil gas samples were submitted to Eurofins for analysis of the full TO-15 Target Compound List according to USEPA Method TO-15 and methane by ASTM D-1946. Completed Air Sampling Forms are provided in **Appendix B**.

Sub-slab soil gas samples were originally collected on October 10th, but due to laboratory error these samples were not analyzed by TO-15.[15] Sub-slab soil gas was re-sampled in all three locations on October 28th and the samples were submitted to the laboratory. Completed Air Sampling Forms are provided in **Appendix B**.

<u>January 2016</u>

An indoor building survey was conducted in Building 42 on January 29, 2016 prior to completing the additional vapor intrusion sampling discussed below. A completed Building 42

[15] Methanol and methane results for these samples were reported by the laboratory.

Survey Form is provided in **Appendix A**. No changes in the building conditions were noted. TVOC concentrations ranged from non-detect to 20 ppb.

Based on the results of the October 2015 sampling, an additional round of sub-slab soil gas samples (B42SSV-1 through B42SSV-3), co-located indoor air samples (B42IA-1 through B42IA-3), and an ambient air sample (B30/42AA) were collected in January 2016. Sample locations are shown on **Figure 17**.[16] As Building 42 is occupied 24 hours per day and seven days per week, and due to its importance for operation of the facility including instrument testing and maintenance activities, the HVAC systems were operating during the collection of the sub-slab and indoor air samples from those areas.

Indoor and ambient air samples were collected using a 6-liter passivated canister equipped with a 24-hour flow controller and particulate filter (TO-15 and ASTM D-1946) and a sorbent tube with a low flow air pump, programmed to pump 6 liters of air over a 24-hour period (TO-17). Canisters and sorbent tubes were positioned such that the sample inlet was approximately four feet above the ground floor. One ambient air sample (B30/42AA) was collected concurrently with the indoor air samples to establish outside background air quality conditions. Sample B30/42AA was located approximately 500 feet upwind (east) of Building 42 (see **Figure 17**).

Sub-slab soil gas samples (B42SSV-1 through B42SSV-3) were then collected at the sampling port locations. The sub-slab soil gas samples were collected over a five-minute period in a 1-liter passivated canister equipped with a five-minute flow controller (TO-15 and ASTM D-1946) and in a sorbent tube with a low flow air pump calibrated to collect one liter of gas over a five-minute period (TO-17).

Indoor air, ambient air, and sub-slab soil gas samples were submitted to Eurofins for analysis of VOCs according to USEPA Method TO-15, naphthalene by TO-17, and methane by ASTM D-1946. Completed Air Sampling Forms are provided in **Appendix B.**

All Building 42 indoor air, ambient air, and sub-slab soil gas data was validated according to procedures provided in prior Work Plans and QAPPs.

7.3. Vapor Intrusion Investigation Sampling Results

Two rounds of indoor air and sub-slab soil gas sampling was completed in Building 42 in October 2015 and January 2016. The results of these sampling rounds are discussed below.

[16] No duplicate samples were as collected at Building 42 during the January 2016 sampling as the requirements for duplicate samples were met by the collection of duplicates at Building 30 which were collected during the same period of time.

7.3.1. Sub-slab

Validated analytical results for the October 2015 and January 2016 Building 42 sub-slab soil gas samples are provided in **Table 11**. Analytical results are provided for the Building 5 Area COCs[17] as well as other TO-15 compounds, naphthalene by TO-17, and methane. The industrial sub-slab soil gas screening levels for the Building 5 Area COCs and other compounds, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 11**. Concentrations that exceed the industrial sub-slab soil gas screening level are shaded. The distribution of selected compounds (Building 5 Area COCs and any compound which exceeded an industrial screening level in Building 42) in sub-slab soil gas samples is illustrated in **Figure 18**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Building 5 Area COCs

Sampling results indicate the following Building 5 Area COCs were detected in at least one sub-slab soil gas sample, including benzene, ethylbenzene, toluene, total xylenes, acetone, MIBK, and isopropyl alcohol. Methanol was not detected in any sub-slab soil gas sample.

A comparison of the industrial sub-slab soil gas screening levels to the sub-slab soil gas sampling results indicates that the concentrations of all Building 5 Area COCs were below their industrial sub-slab soil gas screening levels.

Other Compounds

The validated analytical results for other TO-15 compounds detected in sub-slab soil gas samples collected beneath Building 42 are also provided in **Table 11**. The distribution of selected compounds (Building 5 Area COCs and any compound which exceeded an industrial screening level in Building 42) in sub-slab soil gas samples is illustrated in **Figure 18**. A number of other TO-15 compounds were detected in sub-slab soil gas samples collected beneath Building 42. A comparison of the industrial sub-slab soil gas screening levels to the sub-slab soil gas analytical results indicates that no compounds were detected above their industrial sub-slab soil gas screening levels.

[17] Building 5 COCs include benzene, ethylbenzene, total xylenes, acetone, MIBK, isopropyl alcohol, and methanol.

Methane

Methane was detected in each sub-slab soil gas sample collected in Building 42. Methane was detected at concentrations three orders of magnitude less than 10 % of the methane LEL of 5% or 0.5%.

7.3.2. Indoor Air

Validated analytical results for the October 2015 and January 2016 Building 42 indoor air sampling events are provided in **Table 12**. Analytical results are provided for the Building 5 Area COCs as well as other TO-15 compounds, naphthalene by TO-17, and methane. The industrial indoor air screening levels for the Building 5 Area COCs and other compounds, derived from the USEPA VISL Calculator (USEPA, 2015b), are also shown on **Table 12**. Concentrations that exceed the industrial indoor air screening level are shaded. The distribution of selected compounds (Building 5 Area COCs and any compound which exceeded an industrial screening level in Building 42) in indoor air samples is illustrated in **Figure 19.** Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Building 5 Area COCs

Sampling results indicate the following Building 5 Area COCs were detected in at least one indoor air sample during the October 2015 and January 2016 sampling events, including benzene, ethylbenzene, toluene, total xylenes, acetone, MIBK, and isopropyl alcohol. Methanol was not detected in any indoor air sample.

A comparison of the industrial indoor air screening levels to the indoor air sampling results indicates that the concentrations of all Building 5 Area COCs were below their industrial indoor air screening levels.

Other Compounds

The validated analytical results for other compounds in the indoor air samples collected in Building 42 are also provided in **Table 12**. The distribution of selected compounds (Building 5 Area COCs and any compound which exceeded an industrial screening level in Building 42) in indoor air samples is illustrated in **Figure 19**. A number of additional other compounds were detected in indoor air samples collected in Building 42.

A comparison of the industrial indoor air screening levels to the indoor air analytical results indicates that only naphthalene was detected above its industrial indoor air screening level (0.36

µg/m^3) at sample location B42IA-1 in both October 2015 and January 2016 by Method TO-15 at estimated concentrations of 1.3 J and 0.59 J ug/m^3 respectively. In January 2016, the concentration of naphthalene by TO-17 was below the industrial indoor air screening level at B42IA-1 (0.12 µg/m^3).[18] Naphthalene was not detected above its industrial indoor air screening level at any other location in Building 42.

Methane

Methane was detected in all indoor air samples collected in Building 42. Methane was detected at concentrations lower than 10 % of the methane LEL of 5% or 0.5%.

7.3.3. Ambient Air

Validated analytical results for the ambient samples collected during the October 2015 and January 2016 sampling rounds are provided in **Table 12**. For comparison purposes, the industrial indoor air screening levels are also provided in **Table 12**. Laboratory analytical reports and validation reports are provided on compact disc (CD) in **Appendix C** and **Appendix D**, respectively.

Many of the compounds present in the ambient air samples were also detected in the indoor air samples collected during the Building 42 vapor intrusion investigation. Naphthalene, the only compound detected in indoor air above its industrial indoor air screening level, was not detected in the ambient air samples for Building 42.

7.3.4. Recommended Path Forward for Building 42

The vapor intrusion pathway in Building 42 is considered a complete pathway based on the criteria provided in Section 1 as defined by the USEPA (USEPA, 2015a). Naphthalene was the only compound detected above its industrial indoor air screening level using Method TO-15 at one sample location (B42IA-1) in October 2015 and January 2016. However, the naphthalene concentration in sample location B42IA-1 collected in January 2016 and analyzed by Method TO-17 was less than its industrial indoor air screening level. Since Method TO-17 is the preferred low detection analytical method for naphthalene, since sample location B42IA-1 is located in the loading dock area, which is subject to potential outdoor sources of naphthalene, and since naphthalene was detected below its industrial sub-slab soil gas screening level, no additional vapor intrusion sampling is recommended at Building 42. The results of the Building

[18] TO-17 samples for naphthalene were not collected in October 2015.

42 vapor intrusion investigation will be incorporated into the revised Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

8.0 Summary, Conclusions, and Recommendations

Building 7

- Seven sub-slab soil gas samples (six locations and one duplicate), fourteen indoor air samples (six locations and one duplicate for each event), and two ambient air samples were collected during the Building 7 vapor intrusion evaluation.

- A number of compounds were detected in the sub-slab soil gas samples collected beneath Building 7. No compounds were detected above their industrial sub-slab soil gas screening levels.

- 1,2-dichloroehane, chloroform, and naphthalene were detected above their industrial indoor air screening levels. These compounds are discussed below.

- The results of the indoor air sampling conducted in June 2016 indicate that the concentration of 1,2-dichloroethane in one sample was detected above its industrial indoor air screening level. The concentrations of 1,2-dichloroethane in all other June 2016 indoor air samples and all May 2016 indoor air samples were less than its industrial indoor air screening level. Since 1,2-dichloroethane was not detected in any of the sub-slab soil gas samples, it is unlikely that the presence of 1,2-dichloroethane in indoor air is associated with a subsurface source to indoor air.

- Chloroform was detected in four of six indoor air samples collected in May 2016 at or above its industrial indoor air screening level (0.53 ug/m^3) at a maximum concentration of 0.72 J ug/m^3. Chloroform was not detected above its industrial indoor air screening level in any samples collected in June 2016. Chloroform was not detected above its industrial sub-slab soil gas screening level. It is likely that chloroform exceedances are related to the extensive use (cafeteria) of publically supplied water which has been found to contain elevated levels of chloroform in the past in Puerto Rico and use of bleach products, at a minimum. It is likely that the presence of chloroform in indoor air is associated with an indoor air background source.

- Naphthalene was detected at or above its industrial indoor air screening level (0.36 ug/^{3}) at three locations in May 2016 by Method TO-15 at estimated concentrations ranging from 0.41 J to 0.48 ug/m^3. Naphthalene was detected above its industrial indoor air screening level at two locations in June 2016 by Method TO-15 at estimated concentrations of 0.45 J and 0.83 J ug/m^3. The indoor air samples were also analyzed by TO-17, the preferred analytical method for determining low concentrations of

naphthalene. Only one of the samples analyzed by Method TO-17 for naphthalene, with a concentration of 0.37 ug/m^3, exceeded the industrial indoor air screening level of 0.36 ug/m^3. Naphthalene was not detected above its industrial sub-slab soil gas screening level at any of the sub-slab sampling locations. Based on a review of all data, its presence in indoor air is likely related to an indoor air background source.

- No additional vapor intrusion sampling is recommended at Building 7. The results of the Building 7 vapor intrusion investigation will be incorporated into the revised Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

Building 8

- Five sub-slab soil gas samples (three samples and two duplicates from two locations), two indoor air samples (one location and one duplicate), and one ambient air sample were collected in August 2015 and October 2015.

- Benzene, ethylbenzene, MTBE, vinyl chloride, and methane exceeded their industrial sub-slab soil gas screening levels.

- All indoor air samples were below the industrial indoor air screening levels.

- Due to the presence of multiple compounds exceeding the industrial sub-slab soil gas screening levels during multiple sampling events, including benzene, ethylbenzene, MTBE, vinyl chloride, and methane, additional sub-slab soil gas and indoor air samples are scheduled to be collected in 4th Quarter 2016 / 1st Quarter 2017 and the results will be reported to USEPA in the RCRA Corrective Action Program Quarterly Progress Reports.

Building 15

- One sub-slab soil gas sample and one ambient air sample were collected during the Building 15 vapor intrusion investigation.

- A number of compounds were detected in the sub-slab soil gas sample collected beneath Building 15. No compounds were detected above their industrial sub-slab soil gas screening levels.

- Although Building 15 is located in an area where high concentrations of 1,4-dioxane are present in groundwater,1,4-dioxane was only detected in the sub-slab soil gas sample at an estimated concentration of 1.7 J ug/m^3 which is well below the industrial sub-slab soil

gas screening level of 82 ug/m^3 as well as the residential sub-slab soil gas screening level of 19 ug/m^3.

- The vapor intrusion pathway in Building 15 has not been fully evaluated. One co-located sub-slab soil gas and indoor air sample will be collected at Building 15 in 4th Quarter 2016 / 1st Quarter 2017 to further evaluate vapor intrusion. The results will be reported to USEPA in the RCRA Corrective Action Program Quarterly Progress Reports and will also be incorporated into the Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

Building 18

- Six sub-slab soil gas samples (five locations and one duplicate), six co-located indoor air samples (five samples and one duplicate), and one ambient air sample were collected during the Building 18 vapor intrusion investigation conducted in July 2016.

- 1,2-Dichloroethane, trichloroethene, and naphthalene were detected above their industrial indoor air screening levels.

- Naphthalene was detected above its industrial sub-slab soil gas screening level.

- The vapor intrusion pathway in Building 18 has not been fully evaluated. One co-located sub-slab soil gas and indoor air sample will be collected at Building 18 in 4th Quarter 2016 / 1st Quarter 2017 to further evaluate vapor intrusion. The results will be reported to USEPA in the RCRA Corrective Action Program Quarterly Progress Reports and will also be incorporated into the Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

Building 30

- Twelve sub-slab soil gas samples (five locations and two duplicates), nineteen indoor air samples (five locations and three duplicates), and three ambient air samples were collected during the October 2015, January 2016, May 2016, and July 2016 vapor intrusion investigation.

- Benzene, ethylbenzene, total xylenes, vinyl chloride, and methane exceeded their industrial sub-slab soil gas screening levels, particularly in the southwest quadrant of the building.

- 1,2-dichloropropane, ethylbenzene, and naphthalene were detected at concentrations equal to or greater than their industrial indoor air screening levels in several locations prior to the installation/operation of the GAC air treatment system. 1,2-Dichloroethane was detected in one sample above its industrial indoor air screening level after the treatment system began operation, but was not detected in any indoor air samples prior to system operation.

- Due primarily to the presence of naphthalene in several indoor air samples, BMSMC installed five AllerAir air purification (carbon) portable units in Building 30.

- Based on the results of confirmatory indoor air samples collected in May and July 2016, the AllerAir units have performed as designed.

- Confirmatory samples will be collected semi-annually over the next year (December 2016 and June 2017) and the results will be reported to USEPA in the RCRA Corrective Action Program Quarterly Progress Reports and will also be incorporated into the Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

<u>Building 42</u>

- Six sub-slab soil gas samples (two sampling rounds with three locations), six co-located indoor air samples (two sampling rounds with three locations), and two ambient air samples were collected during the Building 42 vapor intrusion investigation.

- A number of compounds were detected in the sub-slab soil gas sample collected beneath Building 42. No compounds were detected above their industrial sub-slab soil gas screening levels.

- Naphthalene was the only compound detected above its industrial indoor air screening level using Method TO-15 at one sample location (B42IA-1) in October 2015 and January 2016. However, the naphthalene concentration in sample location B42IA-1 collected in January 2016 and analyzed by Method TO-17 was less than its industrial indoor air screening level.

- Since Method TO-17 is the preferred low detection analytical method for naphthalene, since sample location B42IA-1 is located in the loading dock area, which is subject to potential outdoor sources of naphthalene, and since naphthalene was detected below its industrial sub-slab soil gas screening level, no additional vapor intrusion sampling is recommended at Building 42.

- The results of the Building 42 vapor intrusion investigation will be incorporated into the revised Human Health Risk Assessment which will be included in the revised Corrective Measures Study Report.

9.0 References

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